



Science to Improve California's Climate and Air Quality Programs

Bart Croes, Chief
Research Division



California Air Resources Board

California Environmental Protection Agency

We regulate emissions

Authorities

Motor vehicles (under Clean Air Act exemption)
Fuels, air toxics, consumer products
Greenhouse gases

Oversight

Stationary and area sources
Transportation planning targets

Process

Public workshops and stakeholder meetings
Public and legislative support

Our policy instruments

Performance-based Emission Standards

Aftertreatment effective but turnover slow

Retrofits and repowering also beneficial

Fuel improvements provide immediate benefits

Incentive Funding

\$150M per year for diesel engines

\$1B for port trucks and equipment

Market-based Programs

Carbon emission trading for large sources under design

Enforcement and Monitoring Programs

Science informs our policies

Legislative Requirements

Automotive Engineer and M.D. on Governing Board

Health-based ambient air quality standards

Extramural research program with external oversight

UC peer review of scientific basis for regulations

Workforce

70% engineers and scientists

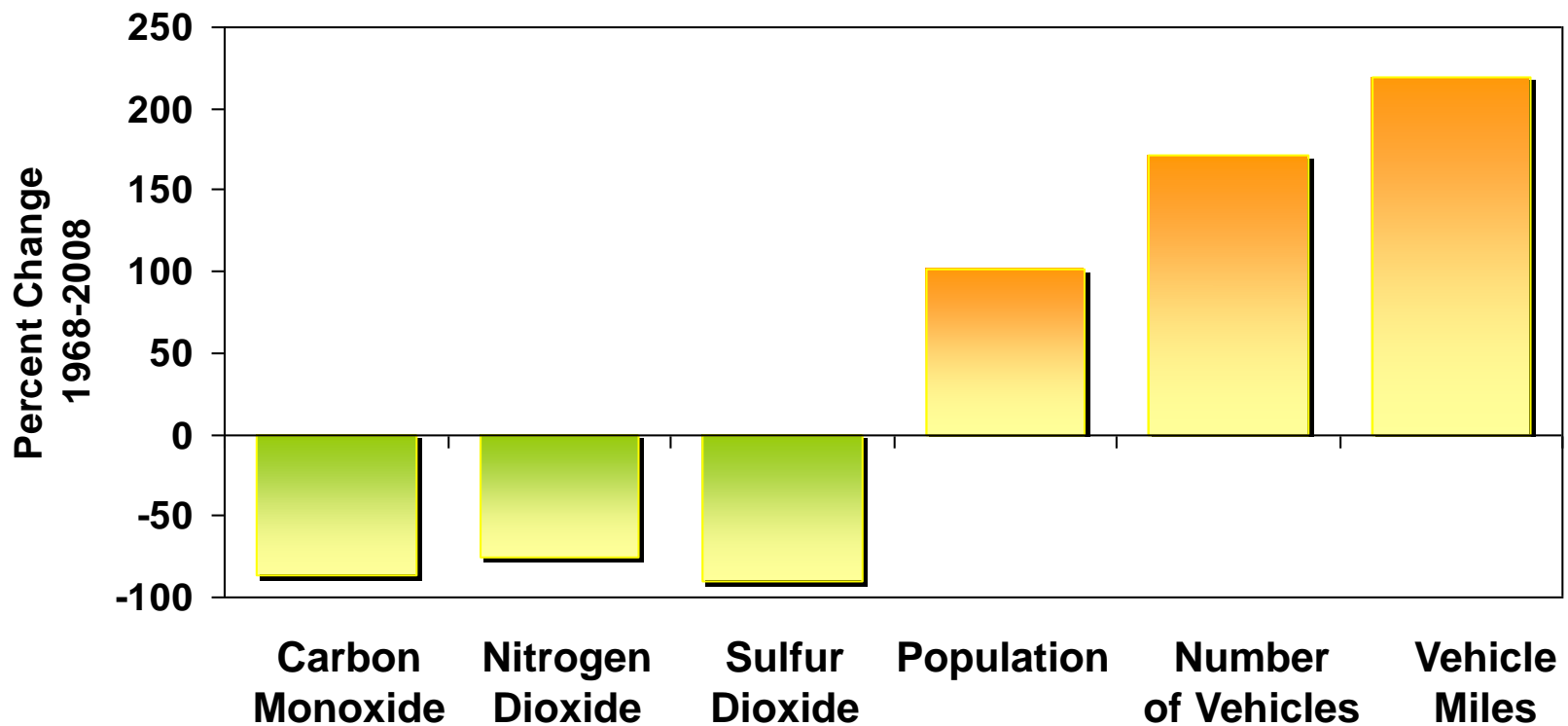
In-house research

Field/modeling studies of major airsheds

70% engineers and scientists

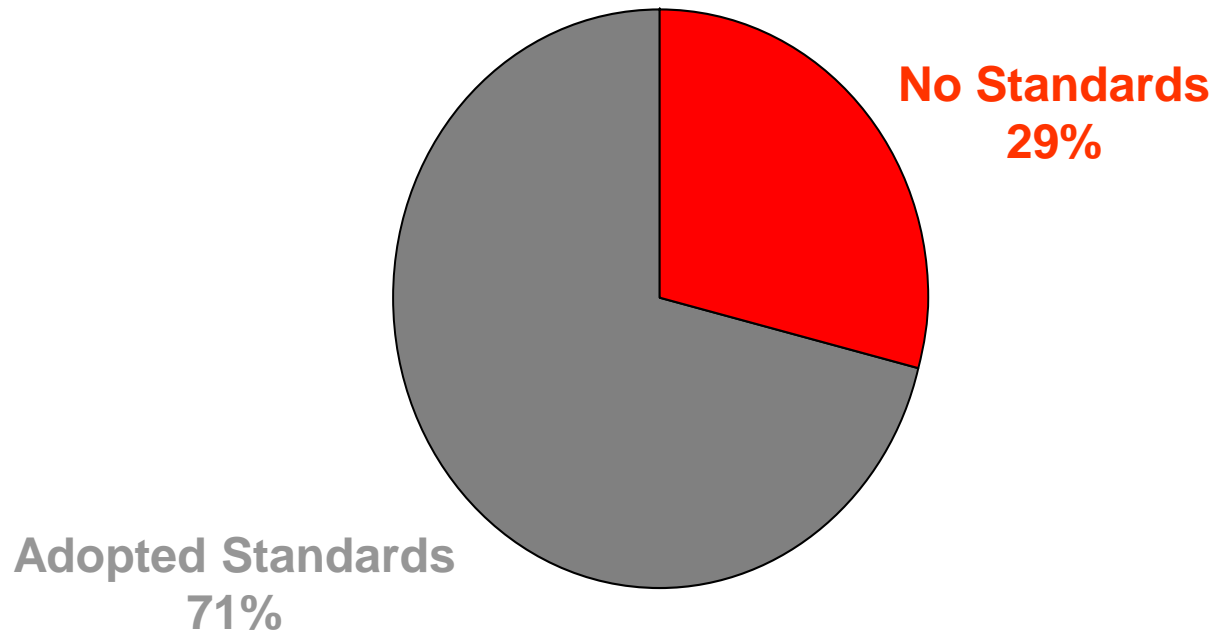
In-house research

Pollution reduced 80% despite growth

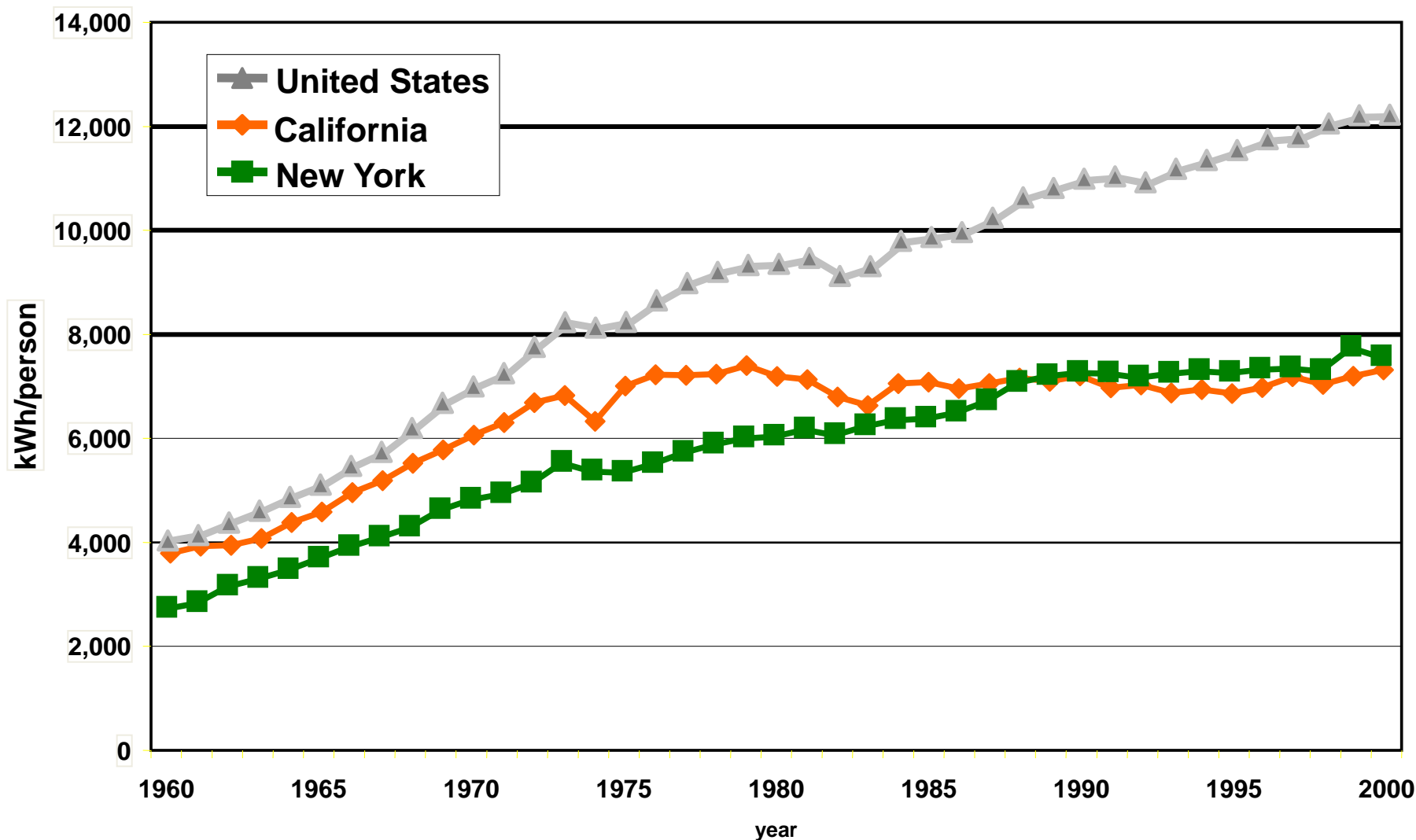


Many countries adopt new engine standards first demonstrated in California

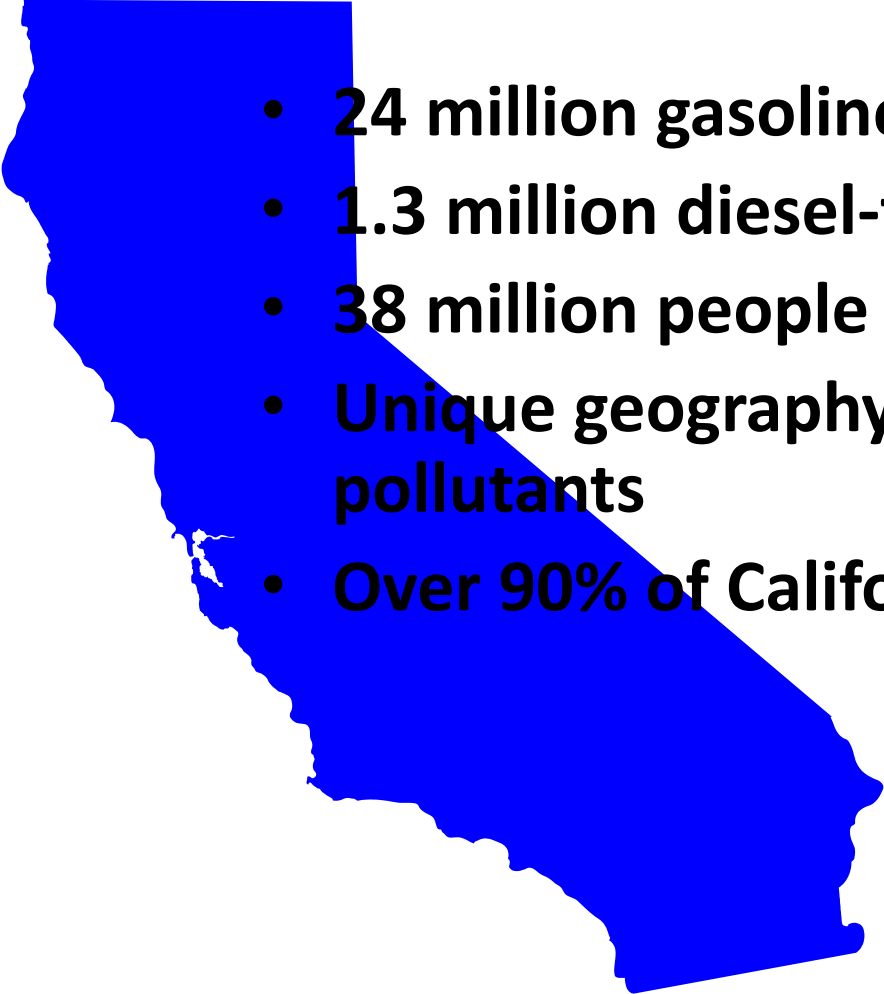
Percentage of **World Vehicles** With
CA/US/EU New Engine Standards



California also leader in energy efficiency



California's Air Pollution Problem

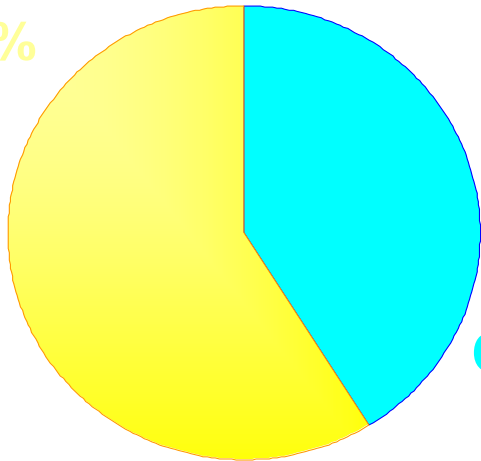
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- **24 million gasoline-powered vehicles**
 - **1.3 million diesel-fueled vehicles and engines**
 - **38 million people**
 - **Unique geography and meteorology confine air pollutants**
 - **Over 90% of Californians breath unhealthy air**

California's Disproportionate Air Pollution Exposure

8-Hour Ozone
(NAAQS = 80 ppb)

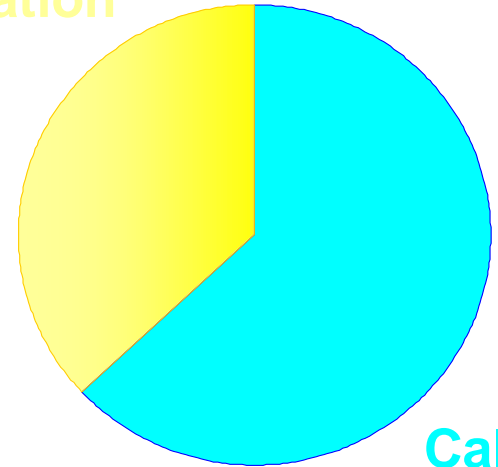
Annual PM2.5
(NAAQS = 15 $\mu\text{g}/\text{m}^3$)

Rest of Nation
59%



California
41%

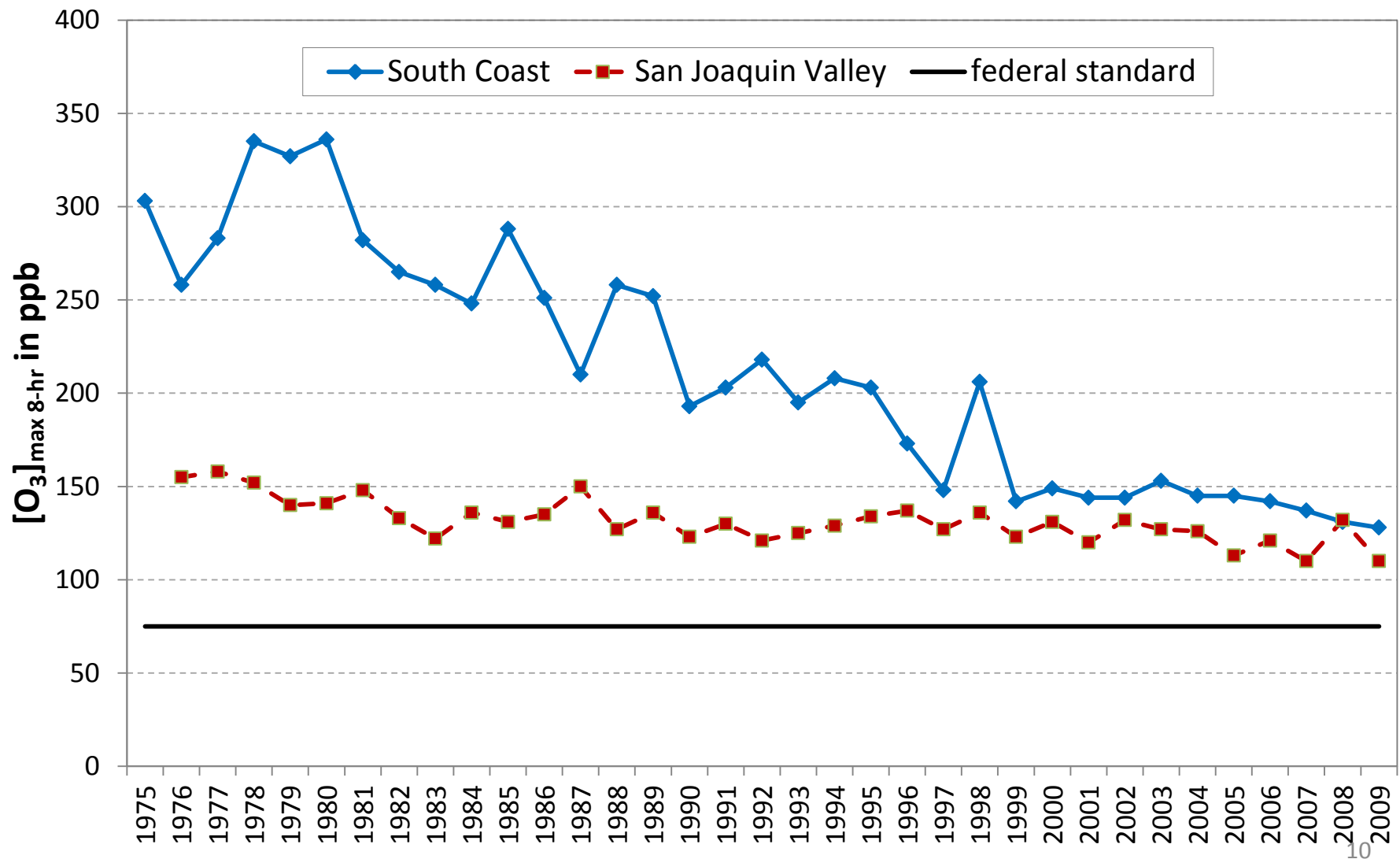
Rest of Nation
37%



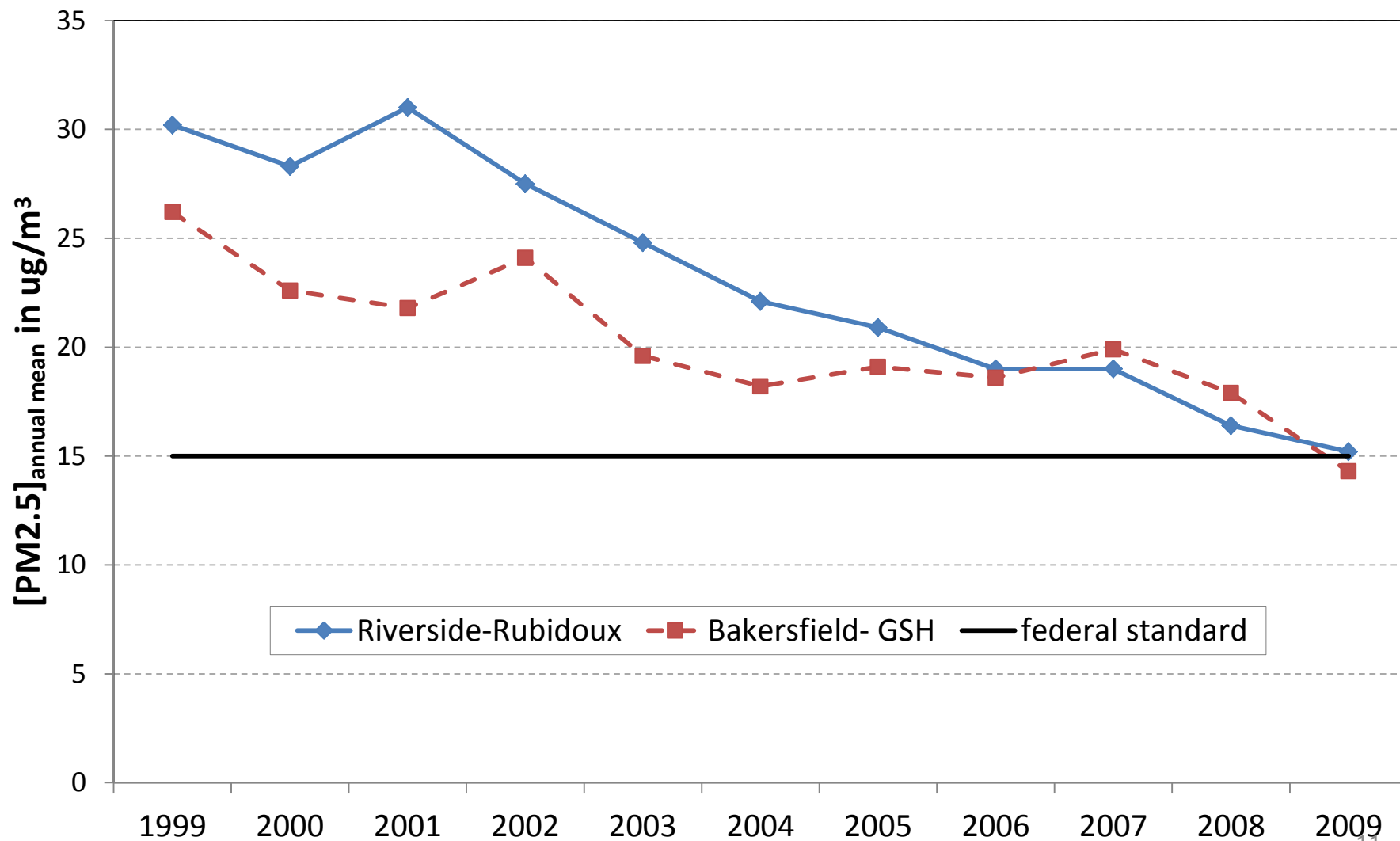
California
63%

Population-weighted and minus national ambient air quality standard (NAAQS), based on 2000-2002 data

Annual Maximum 8-hr Ozone Concentrations 1975-2009



Annual Mean PM2.5 Concentrations 1999-2009



California Climate Impacts over the past 100 years



**1.3°F (0.7° C) higher
temperatures**

7 inch sea level rise

**12% decrease in fraction
of runoff between April
and July**

**snowmelt and spring
blooms advanced
2 days/decade since 1955**

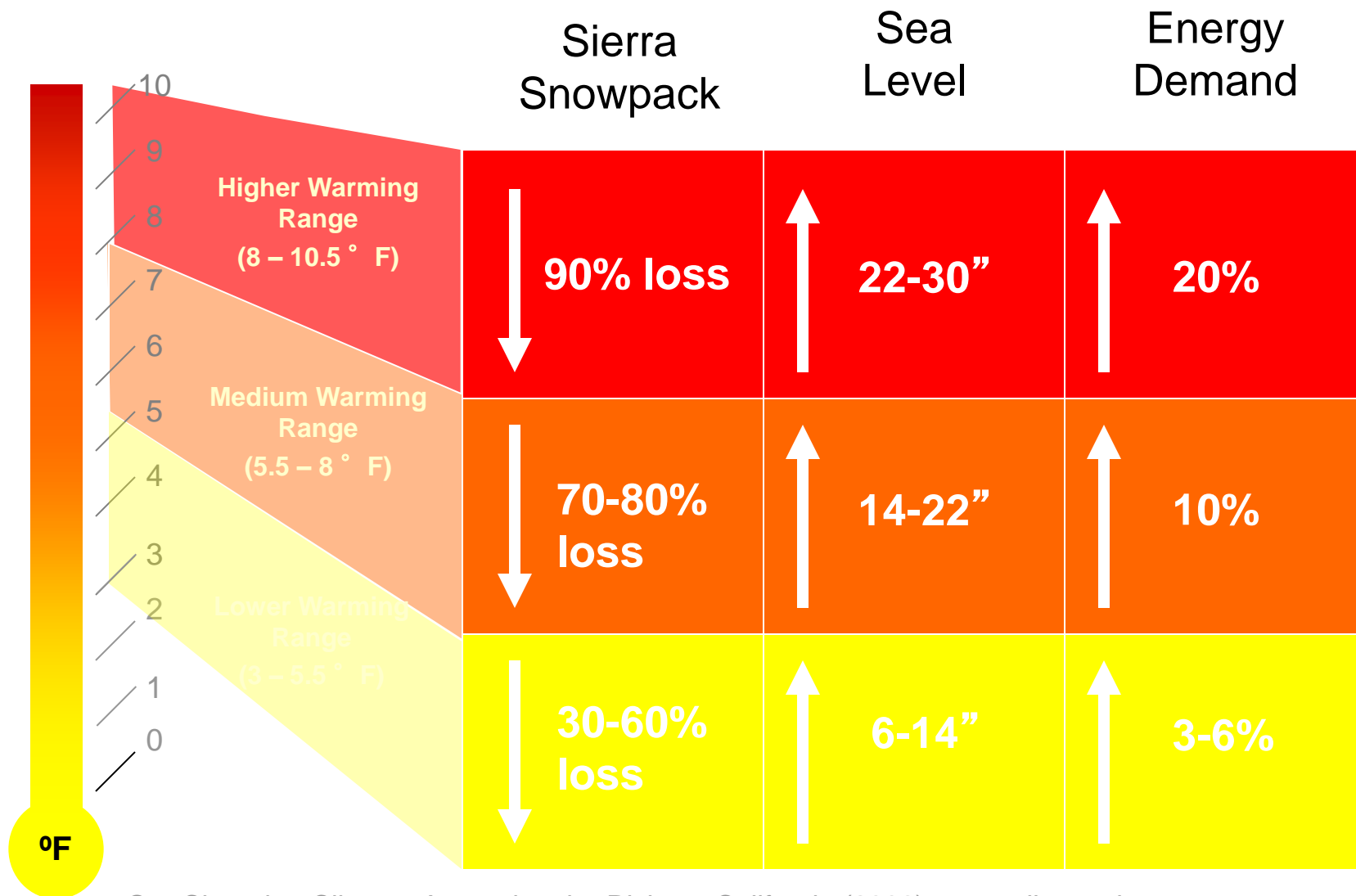
**4-fold increase in wildfire
frequency (over 34 years)**

Cal/EPA-OEHHA, "Environmental Protection Indicators for California" (2002),
www.oehha.ca.gov/multimedia/epic/Epicreport.html

Westerling et al., "Warming and Earlier Spring Increase Western U.S. Forest Wildfire Activity", *Science* (2006)

Projected Climate Impacts on California, 2070-2099

(as compared with 1961-1990)



Our current targets

Air Quality Standards

Attain 8-hour ozone of 75 ppb

By 2014, attain annual PM_{2.5} of 15 µg/m³

Diesel and Goods Movement

By 2020, diesel PM risk 85% below 2000 levels

Greenhouse Gases

By 2020, reduce to 1990 levels

By 2050, 80% below 1990 levels

Challenges addressed by CalNex

Meeting Stringent Air Quality Standards

- Verify VOC and NO_x emissions
- Los Angeles - San Joaquin Valley differences
- Sources of sulfate and organic carbon
- Role and source of high ozone aloft
- Role of transport from East Asia

Meeting Greenhouse Gas Targets

- Verify emissions and trends
- Find under-inventoried sources

Integrate AQ/GHG Control Programs

- Role of air pollutants in climate change
- Identify co-benefits and tradeoffs

How CARB benefits from CalNex

Policy-relevant Science

Addresses 12 primary science questions

World-class researchers

Unprecedented Scope

Statewide, offshore and aloft

First study of nexus issues

Timely Information

Compliance demonstrated for ship fuel sulfur limits

Results expected within two years

RV Atlantis and Sulfur Dioxide Emissions from Ships During CalNex 2010

Eric Williams, NOAA/ESRL/CSD

Results

- 123 ship plume analyses
- All comply with 1.5% fuel sulfur limit
- More than 80% compliance with 0.5% limit
- About 75% less than levels observed in Houston in 2006 (container ships)

